Lab-Assisting Robotic Manipulator (LARM)

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TEXAS A&M UNIVERSITY
ROBOTICS TEAM & LEADERSHIP EXPERIENCE

Problem Definition

Robotic arms prove useful in areas ranging from manufacturing to space exploration. However there is a distinct lack of cheap robot arms that are used in medical and wet-lab settings. LARM aims to develop a robot arm that will perform tasks such as holding instruments & containers, repetitive tasks such as pouring and stirring, and performing aspirations & injections.

Design Approach

The design of LARM focuses on reach, stability, and accuracy. Each step of the design process is optimized to allow the end product to achieve a target position with minimal error.

Design requirements:

- 6 Degrees of freedom to allow for 3-DOF positioning & 3-DOF orienting.
- Minimum reach of .6m (≈2ft).
- Minimum payload of 1kg (2.2 lbs).
- Compact design to prevent obstacle collision.
- 321 Kinematic structure, which creates a wrist joint at which precise motions can be isolated.

Hardware

Our work for Fall '24 consisted mainly of defining our design constraints, followed by motor considerations based on our payload. A general form-factor has been mapped out, as well as the exact design and mechanism for our first two joints.

Summary of joint designs:

- First joint will consist of a 90 N-m stepper motor attached to a belt drive.
- This motor will rotate a platform that houses the second 90 N-m motor.
- Third motor is 24 N-m, followed by three lower-torque motors oriented in a "wrist joint" configuration.
- This wrist joint will allow precise end effector movements and orienting, allowing tasks such as pouring or stirring.

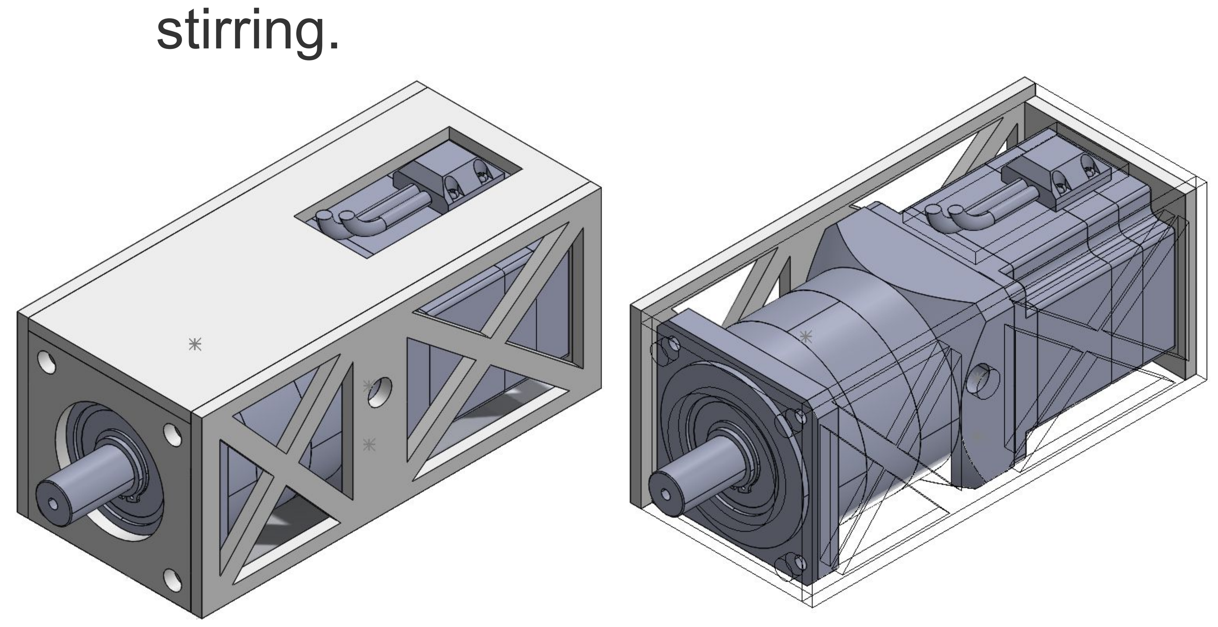

Figure 1: Second motor inside its cage

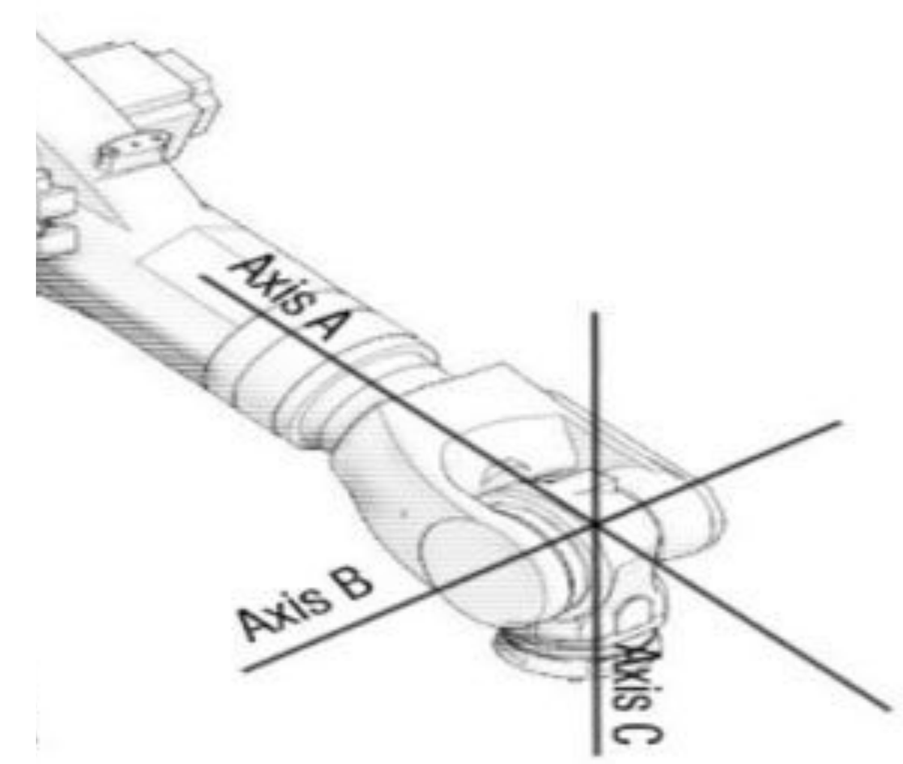

Figure 2: Example wrist joint

Electrical

Our electronics primarily consist of those required for the motors, which include power supplies, cables, and motor controller boards. Our motors are closed-loop, allowing them have precise position control and eliminate lost steps.

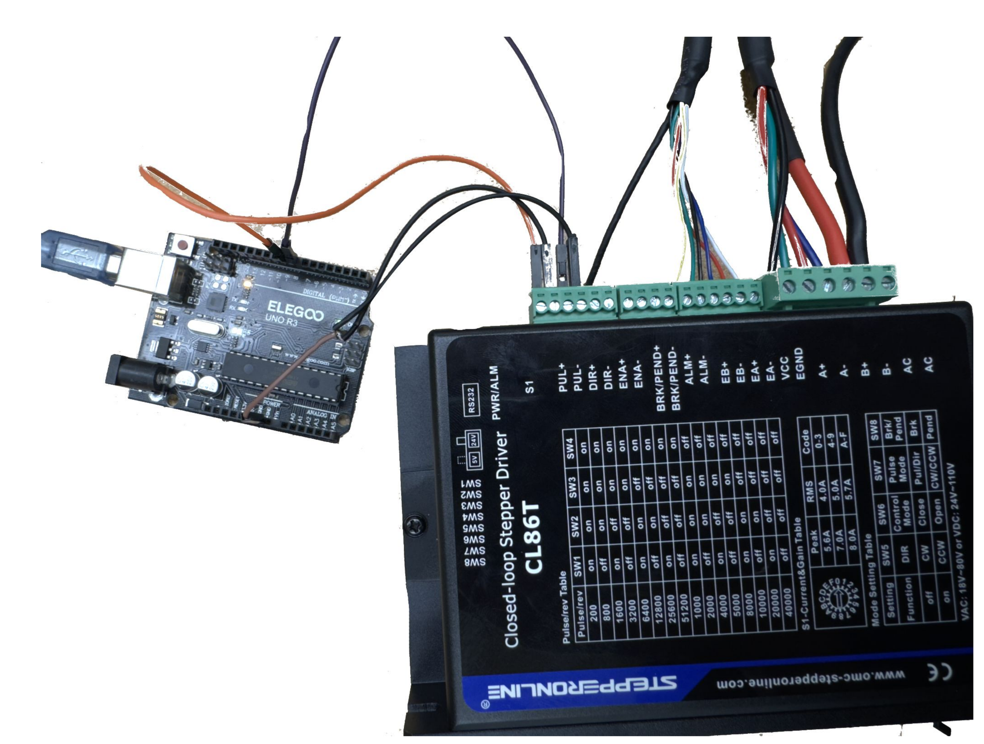

Figure 3: Motor driver connected to controller

Control

An inverse kinematics algorithm will be used to position the robot to a point within its operating space. Our careful design enables the use of Pieper's Method, which splits our 6-DOF problem into two 3-DOF problems, making control significantly easier.

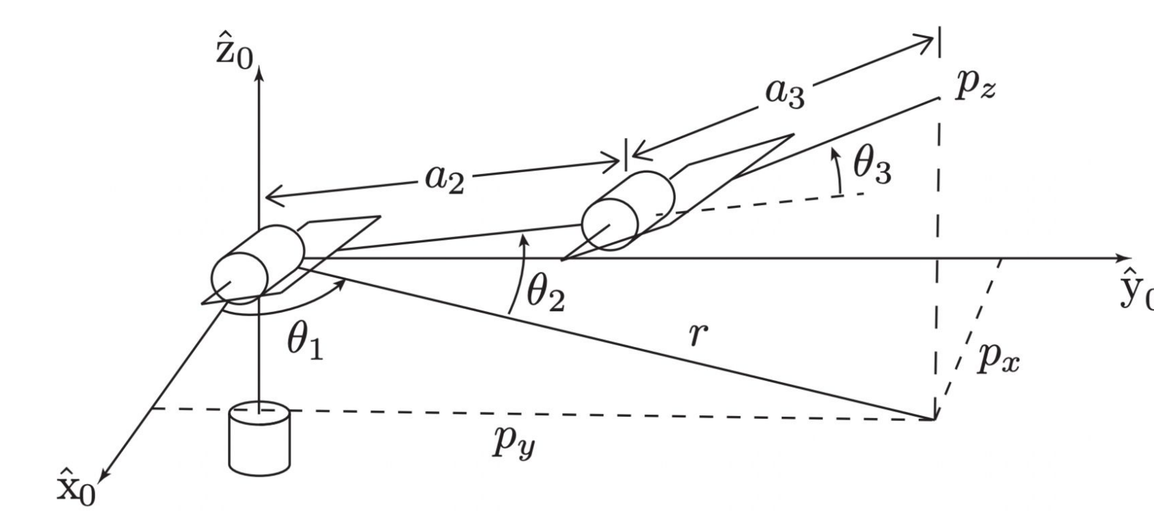

Figure 4: Simplified 3-DOF kinematic diagram

Next Steps

Our next steps involve continuing the mechanical design of our robot:

- Design of link 1 & 2.
- Design of wrist joints and end-effector tools.
- Derive inverse orientation kinematics for wrist joint.
- Manufacturing and assembly of all components.
- Long-term goals: Trajectory & motion planning, object detection using CV.

Texas A&M University Robotics Team and Leadership Experience (TURTLE) Lab